

The Next Generation of Energy

The Renewable Energy and Energy Efficiency Industries in Washington State

*For the Energy Division of the
Washington Department of Community,
Trade and Economic Development*

ECONorthwest
300 Mutual Life Building
605 First Avenue
Seattle, WA 98104

(206) 622-2403

August 1998

EXECUTIVE SUMMARY

WASHINGTON'S CLEAN ENERGY INDUSTRY IN TRANSITION

The energy industry is in flux, as growing competition, new technologies for energy production, and rising environmental concerns about greenhouse gases are all contributing to the reshaping of the industry. Within this context of change, the Washington Department of Community, Trade, and Economic Development commissioned a study of the state's energy efficiency and renewable energy industries. This report describes Washington's energy efficiency and renewable energy industries and explores how those industries are likely to react to current market conditions and public policies.

CLEAN ENERGY IS A BILLION-DOLLAR INDUSTRY

Together, the energy efficiency and renewable energy industries in Washington state generate yearly sales of nearly \$1 billion and employ close to 4,000 people. The energy efficiency industry represents the majority of this revenue and employment.

Energy Efficiency Industry

Washington's energy efficiency industry generates annual sales of about \$780 million and employs approximately 2,900 people earning annual wages of \$128 million. Energy service companies and engineering firms providing a range of energy management services represent the largest component of the efficiency industry with revenues of \$431 million and employment of 1,300 people. Other sectors of the energy efficiency industry include companies that design, build, and install energy efficient lighting systems; various controls and other electrical equipment; and heating, ventilating, and air conditioning (HVAC) systems.

This report's estimate of the size of the energy efficiency industry is conservative because it only includes firms that identify themselves as working in the energy efficiency field or that other organizations have previously classified as members of the industry. Many other companies design, build, and install energy efficient equipment and buildings in their normal course of business but do not identify themselves as members of the energy efficiency industry. State energy codes for residential and commercial construction make most companies involved in new construction and equipment replacement effective members of the energy efficiency business, but these companies are generally not included in this industry assessment unless they have specifically identified themselves as energy efficient.

Renewable Energy Industry

Washington's renewable energy industry generates sales of \$147 million and employs 900 people earning annual wages of over \$32 million. The firms that build and design solar energy systems and related electricity storage and conversion equipment comprise the largest component of the renewable energy industry. Solar companies in Washington generate sales of \$71 million and employ over 420 people. Other renewable energy firms include companies that design, build, or operate biomass fuel systems, small-scale hydroelectric facilities, wind energy generators, geothermal energy plants, fuel cells, and electric vehicles.

CHALLENGES AND OPPORTUNITIES FOR CLEAN ENERGY

With increased competition in electricity generation, public and private utilities have spent less on programs for energy efficiency and renewable energy. Moreover, the introduction in recent years of highly efficient gas turbine generators, combined with low natural gas prices, has driven wholesale prices of electricity down to levels where some energy efficiency and renewable energy investments are not cost-effective. While these trends present near-term challenges for firms in these industries, interviews with company leaders and other industry experts suggest that the long-term prospects for energy efficiency and renewable energy are brighter.

Several large firms in the renewable energy sector currently have significant markets overseas, and they have excellent opportunities to expand their business in developing countries, particularly in remote locations where their technologies are more cost-effective. Public policy initiatives to reduce greenhouse gases also have the potential to expand the market for energy efficiency and renewable technologies substantially. In addition, several policy initiatives proposed as part of the restructuring of the electricity industry would provide dedicated funding to support energy efficiency and renewable energy programs. The majority of firms interviewed in this study felt that with supportive public policies, their companies had strong potential for future growth.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	I
TABLE OF CONTENTS	ERROR! BOOKMARK NOT DEFINED.
1. INTRODUCTION	1
2. ENERGY EFFICIENCY AND RENEWABLE ENERGY: DEFINING THE INDUSTRIES	2
3. CHANGING MARKETS FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY	3
Electric and Gas Utilities	3
Changes in the Market for Electricity	5
Trends in Energy Efficiency	8
Trends in Renewable Energy	8
4. METHODS FOR MEASURING THE CLEAN ENERGY INDUSTRY..	9
Methods for Identifying Clean Energy Firms	9
Methods of Estimating Employment and Business Income	11
Methods for Conducting Company Interviews	12
5. OVERVIEW OF THE ENERGY EFFICIENCY AND RENEWABLE ENERGY INDUSTRIES IN WASHINGTON.....	14
Energy Efficiency	14
Renewable Energy	14
6. ENERGY EFFICIENCY SECTORS	16
ESCOs and Related Engineering Firms	17
Consultants	19
Controls	19
Lighting	20
Heating, Ventilating, and Air Conditioning (HVAC)	21
Other Energy Efficiency Companies	21
7. RENEWABLE ENERGY SECTORS	22
Solar Energy and Related Technologies	22

Biomass, Biofuels, and Municipal Solid Waste	25
Small-scale Hydroelectricity	28
Wind Energy	30
Electric Vehicles	34
Geothermal Energy	35
Fuel Cells.....	35
Other Renewable Energy	36
8. CONCLUSIONS	37
9. BIBLIOGRAPHY	39
APPENDIX A. KEY CONTACTS FOR INTERVIEWS.....	A-1
APPENDIX B. INDUSTRY RESOURCES LIST	B-1
APPENDIX C. SURVEY INSTRUMENTS	C-1

1. INTRODUCTION

The energy industry is in flux, as growing competition, new technology for energy production, and rising environmental concerns about greenhouse gases are all contributing to the reshaping of the industry. Within this context of change, the Washington Department of Community, Trade, and Economic Development commissioned a study of the state's energy efficiency and renewable energy industries. This study describes Washington's energy efficiency and renewable energy industries and explores how those industries are likely to react to current market conditions and public policies.

The energy efficiency and renewable energy industries are vital to the state for several reasons. First, they are an important source of employment and income for a significant number of Washington residents, generating close to \$1 billion in annual revenue and employing over 3,800 people. Furthermore, as these industries develop and expand, they will add new employment and revenue as markets grow within the Northwest, as well as throughout the United States and overseas. Finally, energy efficiency and renewable energy businesses add to the region's quality of life by employing technologies that can reduce some of the harmful effects of our society's reliance on fossil fuels.

The study was undertaken by ECONorthwest, a regional economic consulting firm that has conducted numerous studies on economic and environmental issues associated with energy use in the region. Using confidential state records on employment and firm revenues, ECO estimated the size of the industries by sector. We also conducted thorough interviews with over forty individuals employed with energy efficiency and renewable energy companies to characterize the current state of the industries and to identify key trends and public policy influences. We also conducted some shorter interviews with staff members at key companies. Additionally, we interviewed other industry experts in associations, academia, nonprofit organizations, and government agencies. From these data sources, this report provides a profile of the "clean" energy industries within Washington state.

This report is organized to address the following issues in turn.

- Definition of the Energy Efficiency and Renewable Energy Industries
- General Trends Affecting the Industries
- Methods for Analyzing the Industries
- Overview of Revenue and Employment in the Industries
- Discussion of Market Sectors from Data Gathered in Interviews
- Conclusions

2. ENERGY EFFICIENCY AND RENEWABLE ENERGY: DEFINING THE INDUSTRIES

Renewable energy generally refers to sources of energy that do not rely on fossil fuels for power generation, including solar, wind, geothermal, and biofuels such as ethanol or methane. This study defined the renewable energy sector as including firms engaged in the design, sale, installation, or operation of facilities that utilize these energy sources. The assessment also includes fuel cells and electric vehicles, which are typically considered “alternative energy,” though they may or may not be based on renewable resources. Hydroelectricity also qualifies as a renewable energy source, but for the purposes of this study we did not include employment and revenues associated with the region’s major electricity generating dams. Large-scale hydroelectric plants are carefully regulated and their economic contribution is well documented in other reports, and we have excluded them from this particular study.¹ We did, however, include the design and engineering services associated with the development and operation of small-scale hydroelectric facilities with 30 megawatts or less of generating capacity, which are generally considered to pose fewer environmental risks than larger hydropower facilities.

The energy efficiency industry is more difficult to define than renewable energy. At some level, every building contractor in the state that follows building codes is in the energy efficiency business since those codes set high standards for insulation, heating, and lighting of new residential and commercial construction. Similarly, every hardware store that sells energy efficient fluorescent light bulbs could be considered in the energy efficiency business. We did not take this expansive view of the industry and instead focused on firms which identified themselves or which other organizations identified as being in the energy efficiency business. Our general approach was to count those firms that identify themselves through industry association memberships as being in the energy efficiency business. This approach likely understates the magnitude of the industry in the Washington economy because many other firms engage in ancillary activities that also enhance the energy efficiency of the region’s homes and workplaces.

Although Washington’s public and private electricity and gas utilities have engaged in programs to improve energy efficiency, they were not included in our profile of the energy efficiency industry. As with hydroelectricity in the renewable energy sphere, the conservation programs of the utilities are well documented by regulatory agencies, public oversight bodies, and independent organizations. A July 1998 report by the Northwest Energy Coalition provides a detailed review of recent changes in conservation activities at the state’s major

¹ For example, the Energy Information Administration, Bonneville Power Administration, Federal Energy Regulatory Commission, and other Department of Energy agencies, as well as independent research organizations have examined the Columbia River hydroelectric facilities and other dams in the region.

public and private utilities.² While we do not include the utilities' employment and revenues from energy efficiency activities in this study, we do count employment in other firms that may have received payment through the conservation and renewable energy efforts of utilities.

Table 1. Sectors of the Energy Efficiency and Renewable Energy Industries.

Energy Efficiency	Renewable Energy
Consultants	Biomass, Biofuels, and Municipal Solid Waste
Controls	Electric Vehicles
Energy Service Companies (ESCOs) and Related Engineering Firms	Fuel Cells
Electrical Contractors and Suppliers	Geothermal
Heating, Ventilating, Air Conditioning (HVAC)	Small-scale Hydroelectricity
Lighting	Solar, Electricity Storage, and Inverters
Other Energy Efficiency	Wind
	Other Renewable Energy

3. CHANGING MARKETS FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY

Before considering the energy efficiency and renewable energy companies themselves, it is important first to examine the market conditions within which they operate. In this section, we briefly review the historic role of the region's utilities and highlight the market trends and environmental issues that are affecting these industries.

ELECTRIC AND GAS UTILITIES

Sixty-four utilities provide electricity to the state of Washington. Puget Sound Energy, created from the merger of Puget Sound Power and Light with Washington Natural Gas in 1997, is the largest utility in the state and the Pacific Northwest. The three investor-owned electric utilities (Puget Sound Energy, Washington Water Power, and PacifiCorp) and the four largest public utilities (Seattle City Light, Tacoma Public Utilities, Snohomish County PUD

² NW Energy Coalition, *Utility Scorecards* (Seattle, Washington: NWECC, July 1998). The report provides information on conservation, renewable, and low-income weatherization activities of the 8 largest electric utilities in the state.

and Clark Public Utilities) serve the electricity needs of three-quarters of the state's population.

The four largest gas utilities in the state are Puget Sound Energy, Washington Water Power, Cascade Natural Gas, and Northwest Natural Gas. These four investor-owned gas companies serve more than 95 percent of the gas market, and the remaining three gas utilities in the state are public. The Washington Utilities and Transportation Commission regulates rates and policies at the investor-owned gas and electric utilities in the state. Together the public and private utilities employ more than 13,000 people and generate total revenues of more than \$3 billion.³

Washington state, and the rest of the Pacific Northwest, has traditionally enjoyed low energy costs relative to elsewhere in the United States. For example, the state ranked 40th in the nation in 1994 energy prices, with most of the ten states with lower energy prices being major producers of petroleum products. In terms of electricity prices, the state ranked even lower. In 1995, the state consumed nearly 2.2 trillion Btus of energy at a cost of \$9 billion.⁴ The major hydroelectric generating facilities on the Columbia and Snake Rivers supply an abundance of cheap power, though generation at coal- and gas-fired power plants is somewhat more expensive. The high cost of the failed nuclear power plant construction program of the Washington Public Power Supply System (WPPSS) raised the Bonneville Power Administration's wholesale electricity rates by nearly a third, but overall electricity prices remain among the lowest in the nation.

In the wake of the planning failures that led to expensive and unneeded WPPSS nuclear plants, public and private utilities in Washington adopted a new planning approach known as least-cost planning or integrated resource planning. This approach considered demand-side resources such as conservation and energy efficiency investments on equal footing with new generation resources. The logic is that if a utility can invest in home insulation and save electricity at a cost of \$0.015 per kilowatt-hour, then it can avoid purchasing new generating capacity that costs \$0.025 per kWh. Because conservation and energy efficiency were often cost-effective relative to the development of many new generating sources and were more environmentally benign than nuclear, coal, gas, or hydroelectric plants, in the 1980s and early 1990s utilities sponsored a variety of program to fund investments in energy efficiency and renewable energy. According to analysis done by CTED, in 1996 Washington utilities spent \$119.6 million on conservation and renewables.⁵

³ Washington Employment Security Covered Employment adjusted to include management..

⁴ Energy Information Administration. 1997. *Annual Energy Review 1997* (Washington D.C.: U.S. Government Printing Office, July, 1998), <http://www.eia.doe.gov>, pp. 14-15.

⁵ Alan Mountjoy-Venning, in memorandum to K.C. Golden, Assistant Director of CTED dated September, 26 1997 (<http://www.energy.cted.wa.gov/LETTERS/pubpurp.html>).

In October 1996, utilities in Washington, Oregon, Idaho, and Montana joined with government agencies, nongovernmental organizations, and businesses to create the Northwest Energy Efficiency Alliance. The nonprofit consortium is dedicated to transforming markets for energy efficiency products and services. Alliance members are promoting market transformation measures as a way to save energy and money over the long term. Utilities in the four-state region pledged \$65 million for NEEA's first three years of activities, but its future beyond 1999 remains uncertain.

CHANGES IN THE MARKET FOR ELECTRICITY

Historically, electricity prices were highly regulated, making the notion of a "market" for electricity something of a misnomer. This regulation was a result of the fact that power production and distribution industries were historically conducive to the creation of a natural monopoly. Competition in such a market tended to fail because one firm could exploit economies of scale and drive out the others by lowering prices. Historically, government has chosen to allow only a single firm to produce and distribute energy within a particular area. In exchange for this exclusive license, firms are regulated in the prices they can charge for the power they produce in order to keep prices at a level below what an unregulated monopoly would charge.

However, in recent years elements of the electricity industry have begun to be restructured, a trend that is expected to continue though its final form is uncertain. Most of the restructuring occurring to date has been in the generation and wholesale of electricity, which are the areas of the electric utility operations that exhibit the weakest arguments in favor of continued price regulation. From 1922 to 1973 the generation of electric power typically operated in the range of decreasing unit costs, meaning that larger generating facilities yielded lower costs per kilowatt-hour produced. The industry is now thought to be operating in the production range of constant unit costs, which means that bigger is no longer cheaper. Also, new production techniques using highly efficient natural gas turbines make small-scale generation projects feasible, removing traditional barriers to entry. In response to this industry transformation, the wholesale market for electricity has moved toward competition.

Technological changes in electricity generation have significantly reduced generating costs and increased efficiency at fossil fuel power plants over the last two decades. Currently, natural gas is the fuel of choice at almost all new electricity generation facilities under construction in the continental United States, and natural gas-fired turbines comprise a relatively inexpensive source of new generating capacity to construct and operate. The new class of efficient gas-fired turbines reduces electricity generation costs and makes it more challenging for renewable energy technologies to compete on an economical basis.

Restructuring has led to rapid changes in the wholesale market. Many new independent power producers have entered the market, demonstrating that barriers to entry in electricity generation have lessened considerably. An active spot and futures market for wholesale electricity has developed, and active bidding among suppliers has driven down the wholesale price of electricity along the West Coast. In a truly competitive market, short-run prices would settle at the additional, or marginal, cost of existing supply. Evidence suggests that competitive bidding in the wholesale electricity market drives wholesale prices to this marginal cost and that the West Coast market has already reached marginal cost pricing. Current wholesale prices in the range of \$0.02 to \$0.025 per kilowatt-hour are close to electricity costs associated with a new gas-fired turbine generator.

The changes in the wholesale market for electricity have raised the prospect of introducing retail competition for residential and commercial customers. Retail market restructuring has not yet occurred in Washington and the movement toward bringing competition into this component of the industry recently has lost momentum in the state Legislature. However, the prospect of restructuring has already reduced conservation investments as utilities are seeking to minimize short-term costs to enhance their competitive positions.

New market forces have tended to threaten the economic viability of some conservation strategies and renewable energy sources because a deregulated market has driven down the price of energy so low that some alternatives are not economically viable. Moreover, demand-side management programs that have developed over the last twenty years, such as utility-subsidized insulation and rebates for energy-efficient light bulbs, have weakened in this competitive environment. In a competitive environment, many customers will seek the low-cost provider, which may be one without the added expense of conservation programs. Moreover, utilities may be reluctant to invest in conservation when they risk losing their customers to a competing utility.

Alternately, restructuring and computer technology may offer new opportunities for monitoring and efficiency. New firms are now in the market to bring billing and other information directly to customers over the Internet. Peak-period pricing is also possible. Like long-distance phone charges, energy consumers could be charged a premium for using energy during times of peak demand, encouraging distribution of demand more evenly throughout the day as people use less energy in the times of peak demand and more in offpeak times. Additionally, competition among energy suppliers will reward those who generate energy efficiently, as they will be the low-cost producers.

This situation does not mean that conservation acquisition is doomed, just that the traditional models funded through utilities no longer work as well. Distributed renewable energy generators, in particular, may benefit from a less centralized resource acquisition model. Multiple, dispersed acquirers of resources, along with increased risk in resource acquisition, will likely favor smaller, more scalable projects. Reworking of existing institutions, especially

pricing of and access to utility infrastructure (i.e., net metering, open access to the transmission system, unbundling and separate purchase of transmission and generation services), may leave distributed renewable energy sources in a better competitive position than in the past. This is especially true because renewable energy sources could be marketed directly to customers who are willing to pay a premium for clean energy.

While recent market trends have weakened the position of some renewables and conservation, environmental concerns about greenhouse warming and other air pollution have resulted in calls for a change in the mix of energy generation as well as a renewal of energy conservation efforts. Though the energy market is losing the characteristics of a natural monopoly, market imperfections still exist in the form of environmental externalities. While market forces may argue for deregulation of some aspects of the energy industry, the growing international consensus about the long-term environmental costs associated with fossil fuels will likely keep public policymakers directly engaged in the promotion of new technologies that are more environmentally benign.

With an understanding of the changing markets and emerging technologies in the energy industry, the public sector can craft new policies to guide the industry to “greener” pastures while maintaining economic efficiency. The prospect of government requirements to reduce the emissions of greenhouse gases already has spurred the development of new energy storage and generation technologies such as hydrogen fuel cells that could radically change the way energy is created, distributed, and used. With a significantly expanded market, the economic feasibility of generating electricity from photovoltaic solar cells could also improve substantially.

Another important change in the energy industry is the growing demand for power in the developing world. Many renewable energy technologies are appropriate in parts of the world that do not have a well developed utility infrastructure. By reducing the need for expensive transmission systems, distributed electric systems employing photovoltaic technology can bring electricity into underdeveloped areas at a competitive cost. With its location on the Pacific Rim, Washington has been able to develop a growing international business exporting renewable technologies.

In summary, two broad and opposing trends are affecting both the energy efficiency and renewable energy industries. On the one hand, new gas turbine technology and the trend toward more competition in the electric energy market has driven down prices and utility spending on conservation and renewable energy in the Northwest. On the other hand, international concern over greenhouse gases as evidenced by the 1997 Kyoto Protocol and growing demand for power in the developing world are increasing demand for these products and services. These trends create a host of new opportunities and challenges for Washington’s energy efficiency and renewable energy businesses, which already are among the most advanced in the industry.

TRENDS IN ENERGY EFFICIENCY

Overall efficiency of energy use in the U.S. has improved in the decades since World War II, though total energy use has increased. For example, between 1949 and 1997 the amount of energy required to produce one constant dollar's worth of gross domestic product decreased by 36 percent. At the same time, population growth and an expanding economy more than tripled total energy use, from 30 quads in 1949 to 94 quads in 1997. Despite efficiency gains, per capita energy consumption increased 73 percent over the same period.⁶

Government efforts to promote energy efficiency began in earnest under President Jimmy Carter with the passage of the National Energy Act of 1978, in the wake of the second oil embargo. Federal support for energy efficiency and renewable energy programs ebbed in the 1980s, but the passage of the Energy Policy Act of 1992 marked a renewed interest in energy conservation. New energy efficiency standards for residential and commercial buildings, refrigerators, furnaces, and other home appliances are reducing energy use. The Environmental Protection Agency's voluntary Energy Star program currently recognizes a diverse range of energy-efficient products, including lights, computers, homes, and buildings.

TRENDS IN RENEWABLE ENERGY

Until the advent of the industrial age when fossil fuel use took precedence, essentially all energy use consisted of renewable energy. Today fossil fuels dominate energy production in the U.S., comprising 81 percent of the total. Renewable energy and nuclear power contribute the remainder. Currently renewable energy contributes almost 7 quadrillion Btus to the total U.S. energy production of about 72 quads, or almost 10 percent. However, this figure is dominated by generation at large hydroelectric facilities which comprises about half the total. These major hydropower facilities, like the large federal dams on the Columbia River, pose significant environmental problems of their own and are not considered in this examination of the renewable energy industry. Nationwide, the range of biofuels (including such diverse fuels as wood, wood waste, methanol, ethanol, agricultural waste, peat, municipal solid waste, landfill gases, railroad ties, tires, fish oils, and other materials) is the next largest renewable energy source, comprising nearly 40 percent of the total renewable energy production. Geothermal energy ranked third in 1997 at about 5 percent of renewable energy production, solar energy contributed about 1 percent, and wind energy about one-half percent.⁷

⁶Energy Information Administration. 1997. *Annual Energy Review 1997* (Washington D.C.: U.S. Government Printing Office, July, 1998), <http://www.eia.doe.gov>, p. xix.

⁷Energy Information Administration. 1997. *Annual Energy Review 1997* (Washington D.C.: U.S. Government Printing Office, July, 1998), <http://www.eia.doe.gov>, pp. xxxi, 3, 6-7, 248-259.

4. METHODS FOR MEASURING THE CLEAN ENERGY INDUSTRY

ECONorthwest identified and studied more than 300 companies and other organizations involved in energy efficiency and renewable energy activities in Washington state. A number of utilities, nonprofit organizations, and government entities appeared in our assessment; some of them are noted for information purposes, but we did not include their contribution to our calculations of total employment and gross business income.

METHODS FOR IDENTIFYING CLEAN ENERGY FIRMS

We employed a range of resources in researching the energy efficiency and renewable energy industries in Washington state. We identified companies in these industries through trade associations, publications, government agencies, Internet searches, existing company directories, limited use of Standard Industrial Classification (SIC) codes, and interviews with company leaders and other experts in the field.

The relevant companies cut across many different business sectors. For example, a large civil engineering firm may be involved in a broad range of infrastructure projects, including a few small-scale hydroelectric facilities. A maker of industrial boilers may produce only a few products that are specifically designed to use biomass fuels or municipal solid waste (MSW). A lighting manufacturer may classify 30 percent of its products as energy efficient.

Since no comprehensive information source currently exists for this diverse set of companies, we focused our study on companies that identified themselves as having a renewable energy or energy efficiency focus and those which other organizations had already classified as belonging in the industry (that is, companies included in existing databases). Since we generally relied on self-identification, we expect that our estimates of industry employment and revenues will be conservative.

A limitation of the self-identification approach is that it likely underestimates the overall extent of the energy efficiency and renewable energy industries. For example, this approach might identify a small specialty purveyor of solar-powered appliances, but it could fail to capture a major chain of hardware stores that sells a significant number of solar-powered yard lights among its many other product offerings, even though the total renewable energy business activity at the hardware store is greater. In some cases, self-identification could also lead to overestimation in cases where companies consider the extent of their energy efficiency or renewable energy business activity in very broad terms. For example, most of the lighting and control manufacturers we talked with described their businesses as fully dedicated to energy efficiency.

Association Membership Lists and Trade Journal Directories

To identify relevant companies, we obtained the membership lists of various associations of the energy efficiency industry and specific sectors of the renewable energy industry. We also interviewed association staff members and reviewed relevant trade journals and other association publications.

Existing Databases and Online Resources

We obtained information on about 100 of the energy efficiency companies from a database of energy efficiency companies in the Pacific Northwest that the Bonneville Power Administration developed. We also conducted Internet searches and reviewed relevant directories of companies in the energy industry, including such online resources as the Gridwatch Power Directory, The Source Guide to Renewable Energy Businesses, and the International Energy Administration's GREENTIE (Greenhouse Gas Technology Information Exchange) directory.

SIC Codes

We located some companies in the solar energy sector through a search of six-digit Standard Industrial Classification (SIC) codes using American Business Disk's company directory. Based on discussion with several energy researchers, we determined that using SIC codes for most sectors was not a feasible analytic approach, given their lack of specificity regarding many energy efficient and renewable energy technologies. Additionally, the two state agency databases we used to obtain employment and revenue data classified companies by four-digit, rather than six-digit, SIC codes, which are insufficient to distinguish most categories of energy efficiency and renewable energy companies.

Interviews and Correspondence with Companies and Industry Experts

We located additional companies through interviews with industry experts in academia, government agencies, nongovernmental organizations, and other resource centers, such as the lighting industry's Lighting Design Lab in Seattle. We also identified additional businesses through our interviews with companies in the energy efficiency and renewable energy industries. We specifically asked companies about their competitors as well as their suppliers and downstream users of their products and services.

METHODS OF ESTIMATING EMPLOYMENT AND BUSINESS INCOME

We developed our assessment of the energy efficiency and renewable energy industries using revenue information from the Washington State Department of Revenue and employment data from Washington State Employment Security's ES-202 data series.⁸ These data cover the period from July 1996 through June 1997. This time period represents the Department of Revenue's Fiscal Year 1997, and corresponds with Employment Security's third and fourth quarter of 1996 and first two quarters of 1997.

All of the individual company data used to conduct this analysis are confidential. Strict procedures to ensure the confidentiality of companies' employment and revenue records were observed. The data were only used to assess the overall size of the industry sectors.

We analyzed data from a total of 396 employment sites, including multiple locations of single firms. This number was reduced to 307 by combining the data for all multiple-location sites into a single record for each firm based on the Uniform Business Identifier (UBI) number for each company.

To develop an overall picture of the energy efficiency and renewable energy industries, we calculated three main figures for each of the businesses identified: annual revenue, average annual employment, and annual wages paid. The annual revenue figure was taken directly from the Department of Revenue's database of gross business income used for calculating the state's Business and Occupation (B&O) Tax. The B&O tax is based on gross receipts from business activity in the state, and almost all companies located in Washington or conducting business here are subject to the tax, including corporations, partnerships, sole proprietors, and nonprofit organizations.

We calculated average annual employees by summing the employees reported in each month and dividing the total number by twelve months. Wages paid were reported to the state as quarterly totals, so we summed the four quarters to calculate an annual figure. We did not adjust the employee or wage figures to account for incomplete reporting. For example, if a company of 10 employees went out of business after the sixth month, their average annual employment would appear as 5 (that is, 10 employees reported for six months divided by 12 months).

Two other adjustments were made to the data to develop a representative overview of the industry. First, as part of the interview process, we questioned each company with more than 50 employees about the portion of their business

⁸ ES-202 data is confidential and was used only for the development of industry-wide statistical profiles.

devoted to energy efficiency and renewable energy activities. Then we adjusted the annual totals for revenue, wages, and employment according to the percentage of the business reported as relating to energy efficiency and renewable energy. For example, if a company spent \$100,000 in salaries during the year and 50 percent of its business is related to renewable energy, the adjusted annual wages would be \$50,000.

Additionally, in some cases we were unable to contact or obtain UBI numbers for a few companies. In these cases, we made an assumption that these were smaller firms and calculated their annual totals based on an average of the bottom quartile of the entire sample. Based on the calculated average of the bottom quartile, with some rounding, we estimated that these are two-person firms with annual revenues of \$150,000 and annual wages of \$60,000. By making this assumption and calculation, we are able to include these firms in the overall calculation for the sector and present a better picture of the industry. Some firms with missing UBI numbers may have gone out of business or have either higher or lower actual figures for employment and revenues.

METHODS FOR CONDUCTING COMPANY INTERVIEWS

ECONorthwest conducted interviews with over 50 representatives from Washington energy efficiency and renewable energy firms. From the database of several hundred firms, we developed a list of potential interviewees designed to represent the diverse range of sectors within the industries. For renewable energy, the interviewee list contained companies from solar energy, wind energy, biomass or municipal solid waste, small-scale hydroelectric, geothermal energy, and other miscellaneous companies. For energy efficiency, energy service companies, consulting firms, lighting companies, HVAC, utilities, and other companies were included on the list. We also focused on large companies to ensure that we accounted for their relative weight within the industry; that is, we placed a priority on contacting the key companies in each sector.

CTED's Energy Policy Group reviewed and approved the proposed list of interviewees before we conducted the interviews. When the company contact person listed in our database was not available (due to vacation schedule, unwillingness to participate in the study, or a move to another company) we selected alternate contacts in the same sector from the database of companies. Completion of the interviews involved more than 200 phone calls to energy efficiency and renewable energy companies, including follow-up calls to companies already contacted.

Most people interviewed were principals of the company or senior managers. The interviews contained questions about the company, other firms in the industry, industry trends, and public policies. Typically the interviews took 20 to 30 minutes, and some lasted nearly an hour. We developed questions tailored to each industry. A list of the companies interviewed appears below, and a more detailed listing with contact names is included in Appendix A. Copies of the

telephone interview questionnaires for energy efficiency, renewable energy, and utilities are included in Appendix C.

Table 2. Companies Interviewed Regarding Industry Trends

ENERGY EFFICIENCY	RENEWABLE ENERGY
<p>ENERGY SERVICE COMPANIES (ESCOs) AND RELATED ENGINEERING FIRMS</p> <p><i>Archos Corporation</i> <i>Art Anderson Associates</i> <i>The Bentley Company</i> <i>EMCOR</i> <i>Honeywell</i> <i>Iverson Elder</i> <i>Johnson Controls</i> <i>Landis and Staefa, Inc.</i> <i>MC Squared Efficient Energy Systems</i> <i>Northwest Energy Services</i> <i>Onsite Energy</i> <i>The Opportunity Council</i> <i>Professional Energy Management</i> <i>Proven Alternatives</i> <i>Stoner Associates</i> <i>Utility Bill Advisory Services</i> <i>one unnamed company</i></p> <p>LIGHTING</p> <p><i>Candela/Sparling Engineers</i> <i>Colombia Lighting</i> <i>Efficiency Works</i> <i>Graybar Electric</i> <i>Holophane Lighting</i> <i>Phillips Lighting Company</i></p> <p>CONTROLS</p> <p><i>Electrical Service Products</i> <i>Energy Smart Products</i> <i>Equipment Technology & Design</i> <i>PLC Multipoint</i></p> <p>HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)</p> <p><i>Energy Savings Products</i> <i>MacDonald-Miller Company</i></p>	<p>SMALL-SCALE HYDROELECTRIC</p> <p><i>Canyon Industries</i> <i>HDR Infrastructure</i> <i>Hydro West Group</i> <i>R.W. Beck</i> <i>Sverdrup Civil, Inc.</i></p> <p>BIOMASS</p> <p><i>Ekono</i> <i>Hermann Brothers</i> <i>Pyro Industries</i> <i>Travis Industries</i> <i>PSF Industries</i></p> <p>SOLAR AND RELATED</p> <p><i>Ample Technology</i> <i>Applied Power Corporation</i> <i>JX Crystals</i> <i>Siemens Solar Industries</i> <i>Trace Engineering</i> <i>Wescorp</i></p> <p>WIND</p> <p><i>Advanced Wind Turbine</i> <i>Meteorological Standards Institute</i> <i>Wind Turbine Company</i></p> <p>ELECTRIC VEHICLES</p> <p><i>ECO-Motion</i> <i>Gabriel Marine</i> <i>Wilde EVolutions</i></p> <p>OTHER</p> <p><i>American Line Builders</i> <i>North American Energy Services</i> <i>Power Resource Management</i></p>

5. OVERVIEW OF THE ENERGY EFFICIENCY AND RENEWABLE ENERGY INDUSTRIES IN WASHINGTON

Our review of the energy efficiency and renewable energy industries identified 274 relevant firms located in Washington state, divided almost evenly between the two industries (See Table 3 below). Together, energy efficiency and renewable energy companies comprised nearly a billion-dollar industry, with an estimated \$924 million in revenue in fiscal year 1997. Though the number of firms in each industry is nearly equal, energy efficiency companies represent the majority of the revenues (84 percent of the total for both industries), wages (80 percent), and total employment (76 percent).⁹

ENERGY EFFICIENCY

According to our study, the energy efficiency industry in Washington includes about 134 firms employing nearly 3000 people. Estimated revenues for 1997 were about \$780 million, and total wages paid were \$128 million. More than one-third of the companies are energy service companies (ESCOs) and related engineering firms providing a range of services to industrial, commercial, residential, and institutional clients seeking to reduce their energy use. These companies also contributed about 55 percent of the energy efficiency industry's revenues and 45 percent of its employment. Companies producing control devices and lighting products represented the next two largest sectors, respectively constituting 16 and 15 percent of energy efficiency revenues. However, these figures may be overestimated because companies in these fields tended to report all their business activity as related to energy efficiency, though their definition may be overly broad.

RENEWABLE ENERGY

Our assessment identified 134 firms involved in various sectors of the renewable energy industry in Washington state. In 1997, estimated revenues for these firms totaled \$147 million, and the companies employed about 900 workers. The renewable energy industry in the state covers a range of areas from biomass to small-scale hydroelectric to wind, but most sectors are fairly small, consisting of only a few small companies with relatively low revenues and employment. Solar energy is a significant exception to this pattern. The sector consisting of solar thermal energy, photovoltaics, and related energy storage systems and power inverters contributed nearly half (48 percent) of the total for renewable energy. Two major manufacturers — Siemens Solar Industries, a producer of photovoltaic solar cells, and Trace Engineering, manufacturer of inverters that convert DC to AC current — comprise a large portion of the

⁹ Industry databases, ES202 data, and B&O tax data assembled by ECONorthwest.

Table 3. Washington's Energy Efficiency and Renewable Energy Firms, 1997

	Firms	Revenues	% of	Wages	Employees	% of
	#	(thousands \$)	Subtotal	(thousands \$)	#	Subtotal
Renewable Energy						
Biomass, Biofuels, Muni. Solid Waste	26	54,240	37%	11,940	325	36%
Electric Vehicles	6	3,026	2%	570	16	2%
Geothermal	10	124	0%	12	0	0%
Small-scale hydroelectricity	21	15,452	11%	5,384	119	13%
Solar, Elec. Storage, Inverters	69	71,083	48%	13,692	424	47%
Wind	6	2,255	2%	903	20	2%
General	2	635	0%	202	3	0%
<i>Subtotal</i>	<i>140</i>	<i>146,815</i>	<i>100%</i>	<i>32,703</i>	<i>907</i>	<i>100%</i>
Energy Efficiency						
Consultants	11	4,553	1%	1,382	38	1%
Controls	13	122,347	16%	13,089	308	11%
Electrical Suppliers and contractors	19	56,980	7%	13,022	333	11%
Energy Service Companies (ESCOs)/Engineers	47	430,901	55%	67,814	1,292	45%
Heating, Ventilation, Air Conditioning (HVAC)	8	17,558	2%	5,025	106	4%
Lighting	16	116,233	15%	20,952	652	23%
General	20	28,343	4%	6,593	165	6%
<i>Subtotal</i>	<i>134</i>	<i>776,916</i>	<i>100%</i>	<i>127,877</i>	<i>2,895</i>	<i>100%</i>
Total	274	923,731		160,580	3,802	
Energy Efficiency as % of Total	49%	84%		80%	76%	

Source: Industry databases, ES202 data, and B&O tax data assembled by ECONorthwest

sector, but numerous smaller solar device producers, distributors, and other related companies make solar energy a significant industry in Washington.

In the biomass category (37 percent of the renewable energy total), Pyro Industries and Travis Industries are two major pellet stove manufacturers that anchor employment and revenues for their diverse sector, which also includes some forest product companies and a few industrial equipment manufacturers. Small-scale hydroelectric activities are in decline, and geothermal is essentially nonexistent. The wind energy sector is small at present, but it is ripe for expansion as the next generation of high-tech wind turbines develops. Fuel cell companies are not included in the total, but several are currently researching this promising technology, though no commercial products are yet available.

For many renewable energy companies, estimates of current revenues and employment may not adequately represent the industry's potential contribution to the Washington state economy. For example, wind energy is currently close to competing with natural gas in terms of electricity generation costs, and the next generation of advanced wind turbines, currently under development in Washington with the support of federal funds, may help foster a stronger and larger market. Likewise, fuel cell technologies are primarily in developmental stages in Washington. They have not yet been commercialized, but if effective products are developed, they may help create a significant future market.

6. ENERGY EFFICIENCY SECTORS

In the following sections we present a summary of the results of our interviews with key contacts at energy efficiency companies. In these interviews, company representatives were asked their views on the trends in their industry and the public policies that would help promote their business. While we made an effort to talk to a representative sample of firms, we did not interview every firm in the sector. Therefore, the following summaries should not be interpreted as reflecting the opinion of every firm in the sector.

Many of the firms included in the energy efficiency industry were originally identified in the Bonneville Power Administration's directory of energy efficiency companies in the Northwest. The BPA's database includes more than 400 organizations located in or doing business in the Pacific Northwest region, including about 100 in Washington state. The agency's energy efficiency program developed the directory based on responses to a questionnaire mailed to companies identified through a range of sources. BPA obtained contact information for many companies from lists that the Department of Defense and the Department of Energy's Federal Energy Management Program maintained of energy service companies that were pre-qualified for federal contracts in 1996. BPA also sent its survey to firms

included in the American Public Power Association's list of companies providing energy services and demand-side management products. Additionally, BPA located other potential companies for inclusion through its customer service fairs, and some firms contacted the agency directly to request inclusion the directory.

We obtained a copy of the Bonneville Power Administration's Access database and incorporated those companies located in Washington into our own database. Where feasible, we sought to determine the extent of the energy efficiency involvement of these firms, but in some cases our estimates may err on the side of inclusion by including the bulk of the Washington portion of BPA's directory in our review of the state's energy efficiency industry. In cases where we could not contact a firm directly, we relied on information included in the BPA database.

ESCOs AND RELATED ENGINEERING FIRMS

This sector of the energy efficiency industry includes full-service engineering companies specializing in architectural, mechanical, and electrical engineering as well as energy service companies (ESCOs) which provide a range of energy management services to their commercial, industrial, and institutional clients. Nearly 50 companies compose this category, and together they represent 55 percent of the energy efficiency industry's revenues. We identified the companies in this sector from the membership list of the Northwest Energy Efficiency Council, the Bonneville Power Administration's database of energy efficiency companies in the Northwest, a list from the Washington Department of General Administration of ESCOs practicing in the state, as well as interviews, online searches, and other reference materials.

Despite the significant revenues that this industry sector reported, two of the ten ESCOs we interviewed were closing their offices in Washington because they believed too few profitable opportunities exist in the state. The Northwest is a challenging market for efficiency companies, because energy costs are low, which can result in apathy about energy conservation. Education can play a key role in helping people understand the benefits of energy efficiency, and several interviewees said the state should invest resources in such educational resources.

The state energy code is the driver of energy efficiency in commercial development. For the most part, it has worked well in supporting the efficiency industry. Energy utility policy changes also have a great impact on the industry. Electricity industry restructuring is changing the face of the electricity industry. Interviewees expect competition among utilities to focus on energy prices, which will lead to additional cuts in efficiency programs. After the initial disruptive restructuring period, utilities may begin to renew

their efficiency programs, but only after they have determined the role of such programs in a less regulated market. Reductions in public funding are making it harder to pay for projects and reducing business opportunities for energy service companies. Following reductions in public funding for energy efficiency projects, companies have adapted by financing projects through performance contracts or direct agreements with end users.

Government-mandated conservation and utility-funded conservation programs are the public policies with the greatest effects on the energy efficiency industry. Utility restructuring and the reductions in public funding for energy efficiency will decrease business for these companies.

The state energy office has been extremely helpful in the past. Many firms used the office as a clearinghouse for information. The bulletin board and software were also particularly helpful. Other supportive agencies and associations include the National Association of Energy Service Companies (NAESCO), the American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE), Association of Energy Engineers, and the Northwest Energy Efficiency Council. Currently, energy user awareness is a significant barrier to increasing energy efficiency, and education is needed to raise awareness of the benefits, including demonstration projects to highlight the results.

The larger firms we interviewed generally had a more positive outlook on the future of the industry. They have experienced significant growth in demand for their products, and the performance contracting industry is growing rapidly. Whereas some of the smaller firms in this sector are failing because of a lack of profitable opportunities, these firms are able to do well in the industry because they have several different types of products and services that allow them to succeed in a growing economy. Overall economic growth in the Northwest, and corresponding growth of the construction industry, has helped increase their business.

Utility incentives and enabling legislation will have a great impact on the industry. Federal mandates for energy efficiency have been helpful in building markets for energy-efficient products. These mandates are especially important in Washington state, where the low cost of energy makes energy efficiency projects take longer to pay for themselves. Internalizing the external costs of environmental impacts associated with energy generation from fossil fuels would help raise energy prices, but in the absence of such a radical policy change, subsidies, rebates, and other incentives can help promote energy efficiency.

Some ideas for policies include simpler legislation for performance contracting, expansion of the number of firms eligible for state government Department of General Administration performance based contracts,

mandates for energy efficiency, and a massive communications effort. It is believed that deregulation may actually increase opportunities for business, but is surrounded by uncertainty and will definitely result in confusion. Nationally, the outlook for the industry is generally positive, with rapid growth projected in other parts of the country.

Restructuring of the electric utility industry is the foremost trend affecting these businesses in the short-term. Over the long-term, concerns relating to the environment and global climate change could have a major effect. Industry experts are not projecting strong growth in the near future for this industry. Many interviewees foresee a positive future for the industry in Washington state, though the region's relatively inexpensive energy and significant number of companies will continue to foster a highly competitive local marketplace for energy efficiency services.

CONSULTANTS

This category primarily includes small independent consulting firms specializing in such areas as communications, grant writing, program development, and overall energy conservation activities, rather than the more technically-oriented consulting services provided by ESCOs and similar engineering firms. Eleven consulting firms appeared in this category, and they represented one percent of revenues and employment for the energy efficiency industry. We identified these companies from the membership of the Northwest Energy Efficiency Council, directories of energy conservation consultants, online searches, and other directories.

CONTROLS

This sector of the energy efficiency industry includes firms that manufacture photo controls, control panels for water treatment, computer control systems to automate energy use in buildings, and digital or pneumatic controls for personal environment modules. We identified 13 companies in this category, which represented about 16 percent of total energy efficiency company revenues.

Companies in the controls sector are typically members of the National Association of Energy Service Companies, the Northwest Energy Efficiency Council, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Electrical Testing Laboratories, the Association of Energy Engineers, and the Illuminating Engineering Society. We located companies in this sector from the membership list of the Northwest Energy Efficiency Council, the Bonneville Power Administration's database of energy efficiency companies in the Northwest, as well as interviews, internet searches, and other references.

Reductions in rebates from utilities for energy efficient investments, such as lighting upgrades and relatively slow compliance with new energy codes have impeded growth in the industry. Some smaller firms in the industry have experienced declining business over the past several years. Companies expect more fragmentation of the industry to occur in the future, and anticipate growth in certain specialized industry sectors, such as controls for tunnel lighting.

Public policies with significant impacts on the industry include biannual funding from the Washington State Department of Transportation and federal funds disbursed through the Intermodal Surface Transportation Efficiency Act and the Energy Policy Act of 1992. Interviewees reported they expect utility restructuring to cause some decline in business in this sector, as reductions in rebates and other funding prolong the payback period for energy efficiency projects. It is feared that the fragmented utility industry that emerges will have a detrimental impact on the energy controls industry. The viability of the energy efficiency industry in Washington is not secure, as the state's low energy prices drive manufacturers to sell their products out-of-state. Manufacturers note that the strongest industries occur in conjunction with regulatory codes for energy conservation and where the price of energy is high enough to provide a reasonably short payback period on conservation projects.

Some larger firms have enjoyed increases in their energy efficiency activities in the last several years, though not necessarily in the portion devoted to manufacturing of energy controls. Additionally, economic growth and accompanying new construction in the Northwest have helped expand the market.

LIGHTING

This sector of the energy efficiency industry includes a number of major lighting manufacturers with facilities located in Washington state. The lighting sector contains 16 firms representing 15 percent of the revenues of the energy efficiency industry. Columbia Lighting is the largest company in the field, and it produces a range of energy efficient lighting products. Several national lighting manufacturers have facilities located in Washington, including Philips Lighting, Osram Sylvania, and Holophane. The sector includes several smaller specialty architectural lighting design firms, which have a portion of their work related to energy efficiency. Also included in this sector are several small companies specializing in energy efficient lighting products and retrofit kits.

The energy efficiency portion of the lighting business has increased in the last five years. Federal energy codes have a significant effect on businesses in the sector, and some interviewees believe that state law has an even greater

effect. Companies expect moderate growth in the future, as business tends to be cyclical. Reductions in utility incentive programs for such products as compact fluorescent light bulbs have an adverse effect, but strong mandates for energy efficient lighting in energy codes help ensure the strength of the industry.

HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

The HVAC sector contains large and small companies involved in design, construction, maintenance, and repair of heating, ventilating, and air conditioning systems. Also included are several developers and purveyors of specialized energy efficient heating technologies, including infrared heating systems for large-space applications such as airplane hangars and industrial facilities. We identified eight companies in the HVAC industry as having some energy efficiency business activities, and these companies represented 2 percent of energy efficiency revenues and 4 percent of employment in the industry. To a certain extent, most firms in the HVAC industry are energy efficient even if they do not classify themselves as such, because the technology improvements in new furnaces or air conditioners assures that they are more efficient and less costly than before. The current growth in construction associated with regional population growth and a strong economy is generating more work for these companies, and new energy codes are helping promote more energy efficient HVAC systems in new construction as well as building retrofits. Some ESCOs also engage in HVAC activities, though they were not classified in this category.

We identified companies active in this sector from the Bonneville Power Administration's database of energy efficiency companies in the Northwest, the membership list of the Northwest Energy Efficiency Council, the International Energy Agency's GREENTIE (Greenhouse Gas Technology Exchange) directory, and other relevant reference sources. Companies in this sector belong to the American Society of Heating, Refrigerating and Air-Conditioning Engineers, the Northwest Energy Efficiency Council, and other industry associations.

OTHER ENERGY EFFICIENCY COMPANIES

This grouping includes twenty energy efficiency companies that cut across several categories or were difficult to classify. They tend to be small one or two person firms that focus on a particular market niche including public policy consulting, lobbying, and other consulting.

7. RENEWABLE ENERGY SECTORS

SOLAR ENERGY AND RELATED TECHNOLOGIES

According to the federal Energy Information Administration, U.S. shipments of photovoltaic equipment were valued at \$118 million in 1995, not counting classified military applications. Employment at the 24 photovoltaic manufacturing companies in the U.S. totaled nearly 1600 in 1995. In 1996, 25 companies in the U.S. reported total shipments of 35,000 peak kilowatts worth of photovoltaic cells and modules (not including space and satellite applications), with the vast majority of these photovoltaic cells being exported. Total shipments have increased more than fivefold since 1982 and have almost tripled in the 1990s. During the 1990s, U.S. manufacturers shipped about 7 million square feet of solar thermal collectors each year, but the market has yet to return to its peak of 21 million square feet shipped in 1981. The U.S. leads the world in photovoltaic production, with a 45 percent market share in 1996, though its portion of the total market is shrinking.¹⁰

Washington companies in this sector produce solar electric photovoltaic modules for small systems and infrared-sensitive photovoltaic cells that work in residential heating systems to generate electricity. Other firms in the field include distributors and retailers of solar cells and other sun-powered devices as well as some architectural firms that perform solar-relevant work. The solar category was defined to include related firms that manufacture power inverters and peripheral equipment designed to convert DC current from photovoltaic cells, wind generation, or battery storage to household AC current. Additionally, the sector includes energy storage technologies like batteries and flywheels. We identified relevant companies from the membership lists of the Solar Energy Industries Association and its Washington chapter, the American Solar Energy Society, The Source Guide to Renewable Energy Businesses, an existing compilation of solar equipment vendors in Washington state, as well as interviews, web searches, and other references.

The solar sector includes nearly 70 companies providing products to both domestic and international markets, including off-grid sites, areas with unstable power, and recreational and service vehicles. The international market for solar systems is sizeable, and markets around the globe have grown rapidly in the last 3 to 5 years. A recent study found the global market for solar energy expanded 25 percent between 1996 and 1997, making

¹⁰ Energy Information Administration. 1997. *Annual Energy Review 1997* (Washington D.C.: U.S. Government Printing Office, July, 1998), <http://www.eia.doe.gov>, pp. 254-261.

it the second fastest growing renewable energy sector after wind.¹¹ This growth is projected to continue into the future, and firms are currently adding capacity to keep up with increasing demand. Siemens Solar Industries is the largest U.S. manufacturer of photovoltaic cells, producing 20 percent of the world's supply of silicon crystals for PV panels at its Vancouver plant, and the company aims to nearly double its annual production to 30 megawatts by later this year.¹²

The DC/AC inverters industry has been experiencing rapid growth for the past few years. Firms are facing stiff competition from foreign manufacturers trying to copy their products. Consequently they are always competing to find the latest automation techniques by hiring the best engineers and improving manufacturing facilities. If they can remain ahead, future expectations are promising. Currently, demand for high-quality renewable energy products is significant.

Over the long term, business is affected by the quality of silicon, which has declined for the last several years despite price increases. The current financial crisis in Asia has weakened some markets for U.S.-made solar products in the region. Global climate change and a desire to reduce reliance on fossil fuel, limitations in fossil fuel availability, and public interest in environmental protection all favor growth of the solar industry. Five companies in the industry are in mass production, and the remaining companies are still in the research and development phases. Companies are facing difficulties locating capital investments needed for commercialization. It is often hard to fit their technologies into an appropriate niche with funding, and thus some companies find it difficult to obtain federal funding support.

Policies that interviewees identified as necessary to help strengthen this industry mainly focus on support for research and development, including increased public funding from the U.S. Department of Energy. Reductions in public funding for renewable energy have hurt the industry and delayed pursuit of their research goals. When the federal government shares research and development costs, the viability of projects increases. Federal grants remain critical as many solar products are still in developmental stages. Additional financing for domestic or international projects would increase business opportunities for these firms, and business assistance for expansion efforts would also help bolster the industry. Companies suggested

¹¹ Christopher Flavin and Seth Dunn, *Rising Sun, Gathering Winds: Policies to Stabilize the Climate and Strengthen Economies*, Worldwatch Paper 138 (Washington, D.C.: Worldwatch Institute, November 1997); Lester Brown *et al.*, *State of the World 1998* (New York: W. W. Norton and Company, 1998).

¹² Patrick Mazza. 1998. *How the Northwest Can Lead a Clean Energy Revolution*, Atmosphere Alliance: Solutions to Global Warming. (Olympia: Atmosphere Alliance, June, 1998), p. 9; Personal communications with Clay Aldrich, Seiman Solar Industries.

that state-level matching funds to accompany federal contracts would be particularly helpful.

Taxes, codes and standards, government incentives and subsidies all have a great effect on the industry. In Washington state, tax breaks are not sufficiently aiding the industry, and companies explained that it is difficult to convince the Legislature that this is the case. The state sales tax poses a major barrier to doing business in Washington, and exemptions for renewable energy would help spur the industry. Tax breaks, subsidies of testing sites, and more funding for development efforts would also facilitate growth of the industry.

The Clinton Administration's renewed emphasis on renewable energy is helping promote the industry. Mandated investments in renewable energy projects by utilities increase revenues and create jobs in the solar industry. Other trends positively affecting business include state-level programs designed to increase the use of renewable energy products and the Clinton Administration's Million Solar Roofs initiative. Efforts to reduce greenhouse gas emissions in fulfilling the provisions of the Kyoto Protocol should help expand markets for renewable energy technologies.

Some interviewees were optimistic that electricity industry restructuring would have a positive effect on renewable energy business by expanding opportunities for consumers to select green sources of power and opening new markets. For example, adoption of a "portfolio" approach to utility restructuring would provide customers with opportunities and incentives to support renewable energy sources. However, it is also feared that because utilities are risk-averse, they will be less likely to spend money on renewable energy research and development because of market uncertainty.

Solar energy companies interviewed generally agreed that the renewable energy industry is viable in Washington state and the evidence above supports this conclusion. The quality of life and business environment is conducive to drawing talent to the region, and existing infrastructure and incentives allow for significant growth in the industry. High-quality manufacturing has a strong presence in Washington, and significant grassroots support for renewable energy makes it easier to conduct business here. Use of non-hydroelectric renewable energy is currently low, but it has potential for growth, especially in the eastern half of the state.

Washington currently has a lead role in the U.S. in photovoltaic technologies, and the state government could play a critical in determining whether these companies grow or get surpassed by better funded companies in other states such as California, which is making significant investments in renewable energy resources. Support in the next several years will be especially critical. Washington is in an excellent position to take world

leadership in renewable energy. A significant portion of renewable energy activity is already underway in the state. Many companies are in their infancy, but have significant growth potential.

BIOMASS, BIOFUELS, AND MUNICIPAL SOLID WASTE

Until the turn of the 20th century, biomass, particularly fuelwood, was the world's leading source of energy. According to the Energy Information Administration, biofuels include such diverse fuels as wood, wood waste, methanol, ethanol, agricultural waste, peat, municipal solid waste (MSW), landfill gases, railroad ties, tires, fish oils, and other materials. In 1997, the range of biofuels accounted for 2.7 quadrillion Btus (quads) of the total energy production of 72 quads, or 3.8 percent. After hydroelectric power, biomass is the second largest sector of renewable energy production in the U.S., comprising about 38 percent of the total in 1997. In the western U.S., wood energy dominates the biofuel sector, representing consumption of 590 trillion Btus while waste energy and ethanol comprised only 114 trillion Btus in 1997. In the Midwest, ethanol production constitutes a major portion of the biofuels industry, with more than a billion gallons produced annually.¹³

Washington state currently has two ethanol production sites. Although the state is not a major producer of ethanol, the Georgia-Pacific forest products company in Bellingham, which produces about 7 million gallons of ethanol annually; and the Pabst Brewing company in Olympia that accounts for another 700,000 gallons. Ethanol is used as a gasoline additive by some petroleum companies although its use has fallen since oxygenated fuels are no longer required to meet local air quality standards in the region.

Despite production declines in recent years, Washington state remains a leading timber producer, and wood byproducts are a significant source of biomass fuel in the state. Most wood and MSW-based biomass energy in the state is used for industrial purposes and residential heating, though some biomass is used in utility electric generation. In 1990, the state's sewage treatment plants generated about 1.4 trillion cubic feet of biogas, much of which was burned in boilers to provide heat for facilities and waste processing.

The biomass, biofuels, and municipal solid waste sector of Washington's renewable energy industry generally consists of three types of companies:

¹³ Energy Information Administration. 1997. *Annual Energy Review 1997* (Washington D.C.: U.S. Government Printing Office, July, 1998), <http://www.eia.doe.gov>, pp. xvii-xviii, 248-253.

- companies associated with the forest products industry that produce biomass fuels as a byproduct or offer consulting services to companies engaged in such activities;
- companies that manufacture industrial boilers and other equipment, including products used for energy production from biomass or municipal solid waste fuels; and
- companies that produce pellet stoves and other wood-fired devices generally intended for residential use.

We located relevant firms from the membership list of the National BioEnergy Industries Association, the biomass and municipal solid waste sections of the International Energy Administration's GREENTIE (Greenhouse Gas Technology Information Exchange) directory, The Source Guide to Renewable Energy Businesses, the *Washington State Directory of Biomass Energy Facilities*, and a database of biomass- and MSW-related companies that Dr. Jim Kerstetter of Washington State University Energy Program developed.

FOREST PRODUCTS COMPANIES

These firms produce wood byproducts for use in energy production. According to company officials, the market for these products is relatively small, and it can be difficult to locate appropriate customers or developers of biomass power plants. One company we interviewed sells most of its wood byproduct to Washington Water Power, the investor-owned utility serving the greater Spokane area, which burns the material in its woodwaste biomass power plant. Competition in the field is mainly with other logging firms that manufacture forest products as their primary business and engage in the energy production sphere as a secondary business. This category also includes consultants to the timber industry that perform some biomass-related work in helping pulp mills and other forest products companies manage their wood byproducts.

INDUSTRIAL EQUIPMENT MANUFACTURERS

Several manufacturers of industrial equipment, such as boilers, gasifiers, grinders, and combustion systems, have some involvement with biomass, landfill gas recovery, or municipal solid waste combustion. For most of these companies, the portion of their business relating to renewable energy is relatively small. Some companies have recently reduced their involvement in the field. For example, one company specializing in the manufacture of equipment for forest products companies (such as debarkers, wood chippers, and other machines used in processing) previously made a single device designed to produce biomass fuel from wood logs byproducts, but the

company was unable to sell the machine successfully and has since ended its involvement in the biomass field.

MANUFACTURERS OF BIOMASS-FIRED RESIDENTIAL PRODUCTS

Washington contains two major manufacturers of biomass pellet stoves, as well as one company that produces wood-fired hot tubs. Pyro Industries in Burlington is the world's largest manufacturer of residential pellet stoves, and it supplies more than 700 specialty retailers, hardware chains, and home improvement stores throughout North America. Unlike conventional wood stoves, pellet stoves use a microprocessor and mechanical air supply system to burn fuel made from compressed wood and agricultural waste in a highly efficient and clean manner. According to Pyro, pellet stoves are typically 8 to 10 times more efficient than conventional fireplaces, 1.5 to 3 times better than wood stoves, and comparable to the best natural gas furnace. Their efficiency advantages, pollution reductions, and ease-of-use are making pellet stoves increasingly popular for residential heating. For Pyro Industries and Travis Industries, the largest employers in the biomass sector, the portions of their employment and revenues ascribed to biomass represent only the percentage of their business associated with pellet stoves, rather than all wood-burning fireplaces, fireplace inserts, and woodstoves. The companies also manufacture some gas-fired stoves, grills, and log sets, but these activities are not included in the employment and revenue calculations.

STATUS AND TRENDS

The timber byproducts and industrial equipment portions of the biomass sector have not grown significantly in recent years. Currently, energy production from biomass and waste-derived fuels is not a growth area because the cost of electricity generation from such facilities typically does not compare favorably with other power sources in the region. For example, Tacoma Power recently halted operations of a 50-megawatt steam-electric plant designed to burn a mixture of coal, wood, and municipal solid waste. Electricity produced at the facility was not priced competitively with other sources, and the utility is currently seeking an organization to purchase or lease the facility. Manufacturers of pellet stoves and other residential biomass products appear to be experiencing slow but steady growth.

Based on our interviews, companies producing biomass fuels from timber byproducts worry that electricity industry restructuring will make it more difficult for renewable resource-based energy products to compete in the marketplace and will lower the demand for their biomass products. Reductions in public funding for renewable energy activities have weakened the market for biomass energy and raised concerns about its long-term stability. To fill this void, companies believe that increased support for

renewable energy is needed from the state Legislature. Conversely, a portion of the population may be willing to pay more for energy derived from renewable sources, and deregulation could help create a larger market for biomass products and generate more work for the business in this sector. Timber-related companies cited the Endangered Species Act as adversely affecting their businesses. The interviewees explained the roots of many problems currently facing the industry lie in trends in the state disfavoring resource-based industries and support for allowing threatened species to dictate land use policies. This portion of the biomass industry is expected to decline with reductions in timber cuts, especially of old-growth logs (which yield more byproducts), as well as efficiency improvements in timber processing.

The manufacturers of pellet stoves and fireplace inserts are experiencing growth as these highly efficient biomass-fueled products gain popularity for residential heating. The companies believe that many pellet stoves are used as a primary heat source, though they recommend a backup heat source since the devices require electricity to operate.

SMALL-SCALE HYDROELECTRICITY

Washington's Columbia River contains some of the largest hydroelectric generating facilities in the nation, and hydropower is a major source of the state's relatively inexpensive electricity. In light of the significant environmental impacts that these large hydroelectric dams pose to riverine ecosystems and aquatic species like salmon, this study included only small-scale hydroelectric activities in its definition of renewable energy. We defined small-scale hydroelectric as those facilities with 30 megawatts or less of generating capacity.

The small-scale hydroelectric industry in Washington state consists mainly of firms in three categories:

- small firms devoted solely to small-scale (and sometimes medium-sized) hydroelectric facilities;
- large civil engineering firms with a portion of their practice including small-scale hydroelectric activities; and
- other firms with expertise in areas not directly related to hydroelectric generation itself, such as facility permitting and fish studies.

Our examination focused on the first two categories, though some companies in the third category are also included. The companies specializing in facility permitting, fish studies, and other related areas typically draw most of their revenues from involvement with larger

hydroelectric facilities, though many have some involvement with small-scale hydropower dams as well. We located firms in the field through the National Hydropower Association, the Northwest Hydroelectric Association, the hydroelectricity section of the International Energy Administration's GREENTIE (Greenhouse Gas Technology Information Exchange) directory, and through web searches, other references, and interviews with experts in the field such as Gil McCoy at the Washington State University Energy Program.

SPECIALIZED SMALL FIRMS

We identified about five companies in Washington state that specialize in small-scale hydropower. These firms are completely devoted to renewable energy production, and they target investor owned utilities and Public Utility Districts as clients. They typically belong to the National Hydropower Association and rely on *Hydro Review* and *Hydro Wire* as information sources for their industry. Currently the market for small-scale hydroelectric projects in the United States is relatively weak. Some environmental scientists and engineers are involved in these projects, but not a significant number.

MAJOR ENGINEERING FIRMS

Several major civil engineering firms in Washington state have been involved in the small-scale hydroelectric field, such as R.W. Beck, Sverdrup Civil, HDR Infrastructure, and Harza Engineering. For these firms, hydroelectricity facilities typically represent only a small fraction of their overall engineering work in such areas as surface transportation, power generation and navigation, and small-scale hydroelectric work is only a portion of their overall work in the hydropower field. These firms provide a full range of services from design, permitting, financing, construction, operation, and monitoring of hydroelectric facilities. In recent years, however, several of these companies have moved out of the sector, and small-scale hydropower activities represent only a small portion of the overall work for those major engineering firms that remain in the field.

Managers of hydroelectric activities for several large engineering companies agreed that the market for small-scale hydropower facilities in the Lower 48 states is currently weak. Environmental concerns have made it more difficult for old facilities to be relicensed or new facilities to be licensed under the Federal Energy Regulatory Commission (FERC). However, economic forces comprise a stronger factor working against these facilities. At present, the cost of constructing and operating new hydroelectric capacity does not compare favorably with electricity generation from natural gas-fired turbines. Small-scale hydroelectric facilities remain more economically

attractive in Alaska, and several engineering firms are involved in projects in the state. Many of these Alaskan projects are partially supported through federal funds provided to Alaska Native Corporations. Despite the weak domestic market, less developed nations represent a potential growth opportunity for the industry. Several companies expressed interest in expanding their international work, though they noted some barriers to export such as insufficient foreign language capabilities and the differing business practices in other nations.

At present, one major firm has essentially discontinued its involvement in small-scale hydroelectric projects because the company does not believe that they represent sound investments given the current low electricity prices. The main work that the company continues to perform in the sector involves engineering modification designed to improve fish passage at existing dams. Several other firms are more active in the small-scale hydroelectric field with a number of projects located in Washington, Alaska, and elsewhere, though their work in the sector has declined significantly in recent years.

STATUS AND TRENDS

The industry has experienced a downturn in recent years. The price of natural gas and the price of energy have an especially large impact on business. National policies like the Endangered Species Act and the decisions of federal agencies, such as the Federal Energy Regulatory Commission (FERC) and the U.S. Environmental Protection Agency, affect the hydropower industry. A firm has to go through several agencies in order to get a license, which some companies felt was overly bureaucratic. They urged more coordination among agencies and a simplification of the licensing process, though other companies explained that the regulatory hurdles are a familiar cost of doing business in the field. Some companies included in the sector also provide consulting services helping would-be hydropower developers navigate the complex permit process. Interviewees noted that support at the federal level is important to the viability of the industry.

In terms of the future, most company representatives expected the domestic industry to continue its decline, for economic and environmental reasons. Net generating capacity of small-scale hydropower facilities is expected to decline as fewer existing sites are relicensed and little new capacity is added to the system. However, most expect overseas demand for such hydroelectric projects to continue to increase.

WIND ENERGY

Production of wind energy in the U.S. has increased more than 50 percent during the 1990s, but it remains less than 1 percent of total renewable

energy production and contributes only a tiny fraction to total U.S. energy production. Total wind power generation in the U.S. has increased almost every year since 1985, despite declines in the amount of new capacity installed each year. Although the U.S. remains the country with the most installed wind power generation capacity, its share of the global wind market has fallen from 92 percent in 1988 to less than one-third today. The majority of U.S. wind projects in operation today are located in California, which represents about 95 percent of the current generating capacity. Additionally, most of the wind generating capacity currently installed in the U.S. was manufactured overseas.¹⁴

Washington state does not have any wind generation facilities on line at present, but 57 megawatts of capacity are planned. Sites with significant wind energy resources in Washington state are located along the Pacific Ocean coast, the Columbia River corridor bordering Oregon, and Ellensburg area in central Washington. A consortium of 8 Public Utility Districts and the Bonneville Power Administration are developing a 25-megawatt Conservation and Renewable Energy System (CARES) wind power plant in Klickitat County.¹⁵

The wind energy industry in Washington state is currently small. Our study identified 6 small companies in the field. Most companies are members of the American Wind Energy Association, and we located the companies through AWEA's membership directory, the wind energy section of the International Energy Administration's GREENTIE (Greenhouse Gas Technology Information Exchange) directory, as well as interviews, web searches, and other references. All the companies are located in the Puget Sound basin, though some are involved in projects in other regions of the state where wind resources are stronger.

The Wind Turbine Company is one of the two companies that the U.S. Department of Energy selected for a major contract to design and test the next generation of wind turbines. The company currently employs 8 people, but it expects to expand to 40 over the next five years.¹⁶ However, the company is weighing options for relocation with the California Energy

¹⁴ Energy Information Administration, U.S. Department of Energy, "Wind Energy Profile," *Renewable Energy Annual 1996* (Washington, D.C.: EIA, April 1997), <http://www.eia.doe.gov/cneaf/solar.renewables/renewable.energy.annual/chap05.html>.

¹⁵ National Wind Technology Center, National Renewable Energy Laboratory, U.S. Department of Energy, "Wind Energy Deployment – Washington," <http://www.nrel.gov/wind/deploy.html> and <http://www.nrel.gov/wind/washington.html>; personal communication with Ben Wolff, Conservation and Renewable Energy System (CARES), Vancouver, Washington.

¹⁶ This employment figure for the Wind Turbine Company is drawn from the Atmosphere Alliance's July 1998 report, *How the Northwest Can Lead a Clean Energy Revolution*, rather than Washington State Employment Security's confidential database

Commission in light of that state's better funding opportunities for renewable energy activities.

The Department of Energy expects the new generation of advanced new turbines to reduce generating costs by at least 20 percent and to help expand markets for U.S. wind technology both domestically and overseas. According to the American Wind Energy Association, costs of electricity generation from wind have decreased by more than 80 percent in the past decade, and prices are approaching the U.S. average for all wholesale electricity. One recent study found that wind energy is the globe's fastest growing energy resource, with generating capacity increasing 28 percent from 1996 to 1997.¹⁷ According to the DOE's Energy Information Administration, generation costs about 5 to 7 per kilowatt-hour but is expected to drop to about 4 cents/kWh with the new wind turbines. The DOE expects demand for wind energy technologies to increase significantly in the next decade.¹⁸

At a time when low natural gas prices are making electricity production in gas-fired turbines relatively inexpensive, many renewable energy technologies are facing difficulty competing in the marketplace. Wind energy prices, however, are the closest of the renewables to the price of electricity production from natural gas. When the lower environmental costs associated with wind energy production versus fossil fuel-based generation are considered, wind power comes out ahead because it produces no emissions. The main adverse environmental effects associated with wind power generation are visual impacts and harm to birds.

The wind companies in Washington design, manufacture, and install wind turbines and generators. The primary markets for their products are developing countries overseas, particularly China and India. These companies work with project developers and electricity utilities in foreign countries to design wind turbines and wind farms adapted to local needs. One of the companies interviewed was going out of business because it lacked sufficient market share and capital, and another company currently had no sales because its wind turbines are under development as part of its contract with the DOE's National Renewable Energy Laboratory in Colorado.

¹⁷ Christopher Flavin and Seth Dunn, *Rising Sun, Gathering Winds: Policies to Stabilize the Climate and Strengthen Economies*, Worldwatch Paper 138 (Washington, D.C.: Worldwatch Institute, November 1997); Lester Brown *et al.*, *State of the World 1998* (New York: W. W. Norton and Company, 1998).

¹⁸ Energy Information Administration, U.S. Department of Energy, "Wind Energy Profile," *Renewable Energy Annual 1996* (Washington, D.C.: EIA, April 1997), <http://www.eia.doe.gov/cneaf/solar.renewables/renewable.energy.annual/chap05.html>; National Wind Technology Center, National Renewable Energy Laboratory, U.S. Department of Energy, "Utility-grade Turbines: Generating Technology for 2000," <http://www.nrel.gov/wind/utility.html>.

Wind energy companies belong to such industry associations as the American Wind Energy Association, the Canadian Wind Energy Association, and the Iowa Renewable Energy Association. The main competition for their products is based in Europe and include Vestas/DWT, Nordtank, Bonus, and Micon of Denmark; Enercon of Germany; Nedwind of the Netherlands; two companies in Spain; and Mitsubishi Wind Energy of Japan. *Wind Power Monthly* from Denmark is a key trade journal in the wind energy industry.

In the early 1980s federal subsidies helped foster a significant market for wind turbines, but the market has since declined. The industry is currently reemerging and is poised for new growth in the next 3 to 4 years. Some wind companies worry that restructuring of electric utilities will put development of renewable energy on hold, with the possible exception of Minnesota, Iowa, Texas, and Colorado, though plans currently exist to install significant new wind generating capacity over the next decade. It is hoped this increase will help revitalize the industry. In the industry's early years, large companies like Boeing and Alcoa were involved in government-sponsored development of large multi-megawatt wind turbines, but they exited the field when the machines did not prove economical in 1980s. Recent gains in efficiency and price decreases have begun to lure large companies like Westinghouse and Bechtel back into the industry.

Policies that subsidize or otherwise lower the costs of fossil fuel-based energy production adversely affect the wind industry. Helpful policies at the federal level include the 1992 Energy Policy Act's production tax credit of 1.5 cent per kilowatt-hour for new projects brought on line between 1994 and 1999 and the accompanying 1.5 cent/kWh production incentive payment paid to public utilities unable to use the tax credits. Federal funding for wind power programs currently comprises less than half its peak level of \$60 million in 1980.

The viability of the wind energy industry in Washington remains uncertain. The current low electricity costs make it difficult for new renewable energy technologies to emerge. Actual sites for wind power generation in Washington state are not as favorable as those in other locations, which may prevent the state from leading the industry. Also, other states like California and Texas are currently taking more active role in fostering their wind industries. One interviewee noted that it is difficult for U.S. companies to compete with foreign manufacturers because of barriers to entry in the European market and because foreign manufacturers typically receive more aid from their governments, which puts US companies further behind. Federal grants and continued efficiency gains in wind power generation could tip the balance in favor of this clean energy technology, and trigger a boost in the wind energy industry in Washington state. In order for future growth in the local wind industry to occur, however, the state needs to maintain or supplement its current base of wind energy companies and prevent the loss of cutting-edge companies to other states.

ELECTRIC VEHICLES

Firms in this category manufacture, sell, and retrofit electric vehicles. We identified six small firms in Washington that are active in the manufacture or conversion of electric vehicles. Each are grass roots type organizations, committed to reducing our reliance on gas powered vehicles and fossil fuels and fighting of a cleaner environment for all. Often family businesses or one-person shops, these firms are struggling to convince people that electric vehicles are the way to go. The enthusiasm and determination of these firms is sustained through their associations in groups like the Seattle Electric Vehicles Association and the North Olympic Peninsula Electric Cars. The main goals of these associations are to educate and teach people about the benefits of electric vehicles and to encourage the adoption of clean technology in everyday life.

In 1967, the Electric Automobile Association of the United States was formed in California to teach and preach the benefits of electric vehicles to the general public. This grass-roots movement has grown and is now active nationally. More recently, major auto manufacturers have come together and formed the Electric Auto Association of America and are trying to create a national commercial trend toward the acceptance of electric vehicles. The adoption of a standard charging system for electric vehicles by GM and Toyota is a first step in the creation of a world standard for electric vehicle charging. This will help in the public acceptance of electric vehicles and encourage people to buy cleaner vehicles. But smaller firms are more effective at putting electric vehicles on the road. According to information obtained in one of the interviews, in the three or four years that automobile manufacturers have been focusing on electric vehicles they have managed to produce and sell 500 to 600 electric powered cars. In contrast, smaller firms have manufactured and converted 8,000 to 10,000 vehicles over the past 10 years.

There is a surprising amount of electric vehicle activity in Washington. According to information contained in another interview, it is estimated that there are 500 to 600 people in Washington driving electric vehicles. On the San Juan Islands, for example, Orcas Power and Light installed five charging stations for the 15 residents that owned electric vehicles and were afraid of getting stranded without power. Kitsap Transit is planning on purchasing some new electric busses from a Tennessee company in the near future. Some electric vehicle manufacturers expressed concern that the current market for electric vehicles is saturated and that growth in future business will need to come from increased public interest in electric vehicles.

Primarily, these firms serve schools, hobbyists, and trade organizations like electric conversion original equipment manufacturers. The market for electric vehicles has increased in size over the last several years at a moderate rate, but overall represents a very small portion of the population.

Legislation like electric vehicle quotas for automobile manufacturers or other incentives to adopt cleaner automobiles is especially effective in their industry, as it creates immediate demand for products. Education is helping to increase the public acceptance of these vehicles, which will encourage use of them in the future. Firms in this category are expecting continued growth in the future.

There are several policies or programs that would help build this sector of renewable energy. Some states have charging stations in convenient locations along the highway for people to recharge as they drive, give tax breaks on state taxes, reduce licensing fees, give a tax credit on the cost of the car, or allow vehicles to drive in HOV lanes during times of peak use. Policies that make the cost of ownership of an electric vehicle more attractive to general users would also help contribute to increasing demand. These incentives would create an infrastructure and encourage ownership in a way that would allow for a more ready adoption of the technology by the general public.

GEOTHERMAL ENERGY

From the membership lists of the Geothermal Resources Council and other sources, we identified about 10 firms in the state that appear to have business activity related to geothermal energy. In our interviews with the firms in this industry sector, however, we did not locate any companies that remain active in the geothermal energy field in Washington state. One company's primary business is manufacturing fiberglass pipes typically used in the transmission of corrosive or hazardous liquids, such as chemicals or petroleum products. In the past, the company had supplied its pipes to geothermal facilities in California because the fiberglass resists corrosion from the outside from acidic soils often found in geothermal areas. Until last year, another company had maintained business activities in geothermal, biomass, wind, and other renewable energy sectors, but it recently sold its renewable energy business areas.

FUEL CELLS

Fuel cells represent an emerging technology in power generation. In a fuel cell, hydrogen gas derived from a fuel such as ethanol or natural gas is converted into energy through an electrochemical reaction in a battery-like device with almost no moving parts. Since the process does not involve combustion, less air pollution is generated than through traditional fossil fuel-based electricity generation. Water and carbon dioxide are the main byproducts of the reaction, and fuel cells generate considerably less carbon dioxide emissions than natural gas-fired turbines or coal-fired power plants.

The Northwest region is an active area for fuel cell development, with Ballard Power Systems, an industry leader, headquartered just to the north in Vancouver, British Columbia. In Washington state, at least two private companies and several utilities are involved in fuel cell development, but they are not included in the database. The projects are currently in the research and development stages, with no commercial products yet, but developers anticipate growth in the near future. Interviewees believe that the industry is currently in a critical phase, and the first company to commercialize new products will capture a significant portion of this potentially sizeable market.

The Spokane Intercollegiate Research and Technology Institute (SIRTI), an alliance of business, industry, academia, and government partners, is sponsoring two fuel cell-related projects with funds from the Defense Advanced Research Projects Agency. SIRTI's new Energy Systems Laboratory, developed with Washington Water Power, hosts the Polymer Electrolyte Membrane (PEM) Fuel Cell Commercialization project. Avista Laboratories, a spin-off of Washington Water Power, is currently developing a small PEM fuel cell plant for on-site power generation. SIRTI is also sponsoring the work of InnovaTek, a Richland-based technology company working to create fuel reformers that will generate the pure hydrogen gas which fuel cells require to operate.

Additionally, King County Metro is currently working to develop an \$18 million, 1-megawatt molten carbonate fuel cell at its East Section Reclamation wastewater treatment plant in Renton. The County is working with Illinois-based M-C Power Corporation to create a fuel cell that would run on hydrogen derived from methane from sewage. CH2M-Hill and Puget Sound Energy have also been involved in this fuel cell demonstration project, the first of its kind, and they may seek to market the technology if it proves successful.

Proponents explain that the potential advantages of fuel cells give them a promising future. For example, their modular design, few moving parts, low pollutant emissions, and ability to generate electricity at remote locations without transmission lines represent significant advantages over traditional means of electricity generation. Increasing the efficiency and lowering the cost of electricity generation are the major challenges facing fuel cell developers, but Washington companies hope to market viable products within the next several years.

OTHER RENEWABLE ENERGY

This category includes companies involved in multiple sectors of the renewable energy industry without a dominant specialty as well as firms involved in supporting roles to the industry, such as those that design and install electrical lines from alternative energy sources to their destinations.

The category is a diverse one, and relevant companies have been undergoing significant changes in recent years, as several firms are merging and others are divesting their renewable energy interests. Deregulation has raised questions about which companies will be key players and how the work will be divided among them.

8. CONCLUSIONS

Together, the energy efficiency and renewable energy industries in Washington state generate yearly sales of nearly \$1 billion and employ close to 4,000 people.

Washington's energy efficiency industry generates annual sales of about \$780 million and employs about 2,900 people earning annual wages of \$128 million. Energy service companies and related engineering firms represent the largest component of the efficiency industry with revenues of \$431 million and employment of 1,300 people. Other sectors of the energy efficiency industry include companies that design, build, and install energy efficient lighting systems; various controls and other electrical equipment; and heating, ventilating, and air conditioning (HVAC) systems.

This report's estimate of the energy efficiency industry is conservative because it only includes firms that identify themselves as working in the energy efficiency area or that other organizations have previously classified as members of the industry. Many other companies design, build, and install energy efficient equipment and buildings in their normal course of business but do not identify themselves as members of the energy efficiency industry. State energy codes for residential and commercial construction effectively make most companies involved in new construction and equipment replacement part of the energy efficiency business, but these companies are generally not included in this industry assessment.

Washington's renewable energy industry generates sales of \$147 million and employs about 900 people earning annual wages of over \$32 million. The firms that build and design solar energy systems and related electricity storage and conversion equipment comprise the largest component of the renewable energy industry. Solar companies in Washington generate sales of \$71 million and employ over 420 people. Other renewable energy firms include companies that design, build, or operate biomass fuel systems, small-scale hydroelectric facilities, wind energy generators, geothermal energy plants, fuel cells, and electric vehicles.

Increased competition in electricity generation among utilities has tended to reduce the amount of money that public and private utilities spend on programs for energy efficiency and renewable energy. Moreover, the

introduction in recent years of highly efficient gas turbine generators combined with low natural gas prices has driven the wholesale prices of electricity down to levels where some energy efficiency and renewable energy investments are no longer cost-effective. While these trends present near-term challenges for firms in these industries, interviews with company leaders and other industry experts suggest that the long-term prospects are positive for energy efficiency and renewable energy.

Several large firms in the renewable energy sector have large markets overseas and have excellent opportunities in developing countries where their technologies are more cost-effective. Public policy initiatives to reduce greenhouse gases also have the potential to increase the market for energy efficiency and renewable technologies substantially. In addition, several policy initiatives proposed as part of the restructuring of the electricity industry would provide dedicated funding to support energy efficiency and renewable energy programs. The majority of firms interviewed in this study felt that with supportive public policies, their companies had strong potential for future growth.

9. BIBLIOGRAPHY

- Alliance to Save Energy. *New York State Energy Efficiency Industry Directory: A Networking and Buying Guide*. Albany, N.Y.: New York State Energy Research and Development Authority, 1997.
- American Solar Energy Society. *1996-97 Membership Directory*. Boulder, Colo.: ASES, March 1996.
- Lester Brown, *et al.* *State of the World 1998*. New York: W. W. Norton and Company, 1998.
- California Energy Commission. *1996 Energy Technology Export Directory of California Companies*. Sacramento, Calif.: CEC, 1996.
- Cost Review Management Committee. *Cost Review of the Federal Columbia River Power System Management Committee Recommendations*. Portland, Ore.: Bonneville Cost Review, 1998.
<http://www.nwppc.org/cr98-01.htm>.
- Energy Information Administration. *Annual Energy Review 1997*. Washington, D.C.: U.S. Government Printing Office, July 1998.
- Energy Information Administration, U.S. Department of Energy. "Wind Energy Profile." *Renewable Energy Annual 1996*. Washington, D.C.: EIA, April 1997. <http://www.eia.doe.gov/cneaf/solar.renewables/renewable.energy.annual/chap05.html>.
- Environmental Services Directory. *1997 Environmental Services Directory for Washington State*. Seattle, Wash.: Environmental Services Directory, January 1997.
- Flavin, Christopher, and Seth Dunn. *Rising Sun, Gathering Winds: Policies to Stabilize the Climate and Strengthen Economies*. Washington, D.C.: Worldwatch Institute, November 1997.
- Mazza, Patrick. *How the Northwest Can Lead a Clean Energy Revolution*. Olympia, Wash.: Atmosphere Alliance, June 1998.
- Mountjoy-Venning, Alan. *Memorandum on Washington Expenditures on Public Purposes*. Olympia, Wash.: CTED, September 26, 1997.
<http://www.energy.cted.wa.gov/LETTERS/pubpurp.html>.
- National Wind Technology Center, National Renewable Energy Laboratory, U.S. Department of Energy. "Wind Energy Deployment – Washington." <http://www.nrel.gov/wind/deploy.html>.

- National Wind Technology Center, National Renewable Energy Laboratory, U.S. Department of Energy. "Utility-grade Turbines: Generating Technology for 2000." <http://www.nrel.gov/wind/utility.html>.
- Northwest Energy Coalition. *Utility Scorecards*. Seattle: NWECC, July 1998.
- Northwest Energy Efficiency Alliance. *1997 Annual Report*. Portland, Ore.: NEEA, 1998.
- Northwest Energy Efficiency Council. *Northwest Energy Efficiency Council Membership Directory 1997-1998*. Seattle, Wash.: NEEC, 1997.
- Puget Sound Energy. *Annual Report of Electric Conservation Programs for the 1997 Calendar Year*. Olympia, Wash.: Washington Utilities and Transportation Commission, February 27, 1998.
- Puget Sound Energy Conservation Service Offerings. *Energy Efficiency Services for Commercial and Industrial Customers 1998*. Bellevue, Wash.: Puget Sound Energy, 1998.
- Puget Sound Energy Information and Referral Services. *Energy Efficiency Services*. Bellevue, Wash.: Puget Sound Energy, 1998.
- Savelle, Jon. "Utilities Not Spending on Conservation, Says Report." *Daily Journal of Commerce*. July 21, 1998. pp. 3, 5.
- Solar Energy Industries Association. *SEIA Members Database: Members Details in Washington State*. Washington, D.C.: SEIA, January 1998. <http://www.seia.org/cgi-bin/php.cgi/db/showco.phtml>.
- The White House Office of the Press Secretary. *The Clinton Administration's Comprehensive Electricity Competition Plan*. Washington, D.C.: The White House, March 25, 1998.

APPENDIX A. KEY CONTACTS FOR INTERVIEWS

ENERGY EFFICIENCY

ENERGY SERVICE COMPANIES AND RELATED ENGINEERING FIRMS

Archos Corporation	Henry Romer, Principal
Art Anderson Associates	Sean Hoynes, President
The Bentley Company	Frank Petrie, Managing Director
EMCOR	Ron Herbst, Director of Performance Contracts
Honeywell	Mark Rohan, District Manager
Iverson Elder	Keith Elder, Principal
Johnson Controls	Dave Silha, Account Executive
Landis and Staefa, Inc	Brian Allens, District Manager
MC Squared Efficient Energy Systems	Roger Absten, Principal
Northwest Energy Services	Mark Longmeier, President
Onsite Energy	Hugh E. Schall, P.E., Vice President
The Opportunity Council	Annette Desolvo, The Energy Assistance Agency
Professional Energy Management	Mark Williams, Principal
Proven Alternatives	Rod Farrow, Principal
Stoner Associates	Dennis Flynn
Utility Bill Advisory Services	Jerry Gintz, President
[One additional firm that requested anonymity]	

LIGHTING

Candela/Sparling Engineers	Mary Clair Frazier
Columbia Lighting	Mark Johnson, Director, Architectural Products
Efficiency Works	Tracy Carroll, President
Graybar Electric	Kurt Sneer, Branch Manager
Holophane Lighting	Mel Weakley, Sales Representative
Phillips Lighting Company	Davis Chastain

CONTROLS

Electrical Service Products	John Thomson, President
Energy Smart Products	Evelyn, CEO
Equipment Technology & Design	Norm Dittman, President
PLC Multipoint	

HVAC

Energy Saving Products	Jerry Hansen
MacDonald Miller Company	Joel Smith, Project Manager

RENEWABLE ENERGY

SMALL-SCALE HYDROELECTRIC

Canyon Industries
HDR Infrastructure
Hydro West Group
R.W. Beck
Sverdrup Civil

Dan New, President
Mike Haynes and Robin Fisher
Scott Jacobs, Project Manager
Ray Hokinson
Glen Aurdahl, Manager of Hydro and Fisheries

BIOMASS, BIOFUELS, AND MSW

Ekono
Hermann Brothers Logging
Pyro Industries
Travis Industries
PSF Industries

Pertti Winter, Vice President
Steve Hermann, Partner
Matt
John, Service Manager

SOLAR

Ample Technology
Applied Power Corporation
Cruising Equipment Company
JX Crystals
Siemens Solar Industries
Trace Engineering
Wescorp

Ruth Ishihara, President
Darryl Anderson, VP of Finance & Operations
George Ure, Sales Manager
Jason Keyes, Manager of Business Development
Clay Aldrich, Marketing/Public Relations
Tom Rentz, Marketing Assistant
Don Thompson, Principal

WIND

Advanced Wind Turbine
Meteorological Standards Inst.
Wind Turbine Company

Robert Poore, Vice President
Janet Lockhart, Vice President
Lawrence Miles, President

GEOHERMAL

Ershigs
Landau Associates

Bob Davis

ELECTRIC VEHICLES

Eco-Motion Electric Cars
Gabriel Marine
Wilde EVolutions

Steve Lough, Principal
Burton Gabriel, Principal
Bob Richard, Principal

OTHER

American Line Builders
North Amer. Energy Services
Power Resource Management

Jan Willis, President
Glen Canavera, Vice President
Ann Donnelly, Principal

APPENDIX B. INDUSTRY RESOURCES LIST

ENERGY EFFICIENCY

Alliance to Save Energy
Washington, D.C.
www.ase.org

American Council for an Energy-Efficient Economy
www.aceee.org

Energy Efficient Building Association
www.eeba.org

Energy Efficient Lighting Association
eela.com

Export Council for Energy Efficiency
www.ecee.org

Lighting Design Lab
Seattle, Washington
www.northwestlighting.com

National Association of Energy Service Companies
www.naesco.org

Northwest Energy Efficiency Alliance
www.nwalliance.org
(503) 827-8416

Northwest Energy Efficiency Council
(206) 292-5592

Northwest Fenestration Efficiency Collaborative
(503) 827-8416

U.S. Green Building Council
www.usgbc.org

World Energy Efficiency Association
www.weea.org

RENEWABLE ENERGY

BIOMASS, BIOFUELS, AND MUNICIPAL SOLID WASTE

American Coalition for Ethanol
(605) 334-3381

Biomass Energy Alliance
(202) 393-1010
www.biomass.org

Biomass Energy Research Association
(800) 247-1755

Biomass Processors Association
(916) 927-1770

Biomass Resource Information Clearinghouse
rredc.nrel.gov/biomass

National Alternative Fuels Hotline
U.S. Department of Energy
Alternative Fuels Program
1925 North Lynn Street
Arlington, VA 22209
(800) 423-1DOE

National BioEnergy Industries Association
122 C Street, N.W., 4th Floor
Washington, D.C. 20001-2109

Northwest Regional Biomass Energy Program
U.S. Department of Energy
(206) 553-2079

Renewable Fuels Association
(800) 542-3835

GEOTHERMAL

Geothermal Education Office

Geothermal Energy Association
www.geotherm.org

Geothermal Heat Pump Consortium
www.ghpc.org

Geothermal Resources Council
www.geothermal.org

National Geothermal Association

HYDROPOWER

National Hydropower Association
www.hydro.org

Northwest Hydroelectric Association
1201 Court Street NE, Suite 303
Salem, Oregon 97301
(503) 363-0121

SOLAR

American Solar Energy Society
(303) 443-3130
www.ases.org/solar

Passive Solar Industries Council
(202) 628-7400
www.psic.com

Solar Energy Industries Association
(202) 383-2600
www.seia.org

Solar Energy International
solstice.crest.org/renewables/sei

Utility PhotoVoltaic Group
1800 M Street, N.W., Suite 300
Washington, D.C. 20036
(202) 857-0898

Washington State Solar Energy Industries Association
(360) 435-8826 or (360) 956-2148

WIND

American Wind Energy Association
122 C Street, N.W., 4th Floor
Washington, D.C. 20001
(202) 383-2500
www.igc.org/awea

Utility Wind Interest Group
111 Wilson Boulevard, Suite 323
Arlington, VA 22201
(703) 351-4495

OTHER RENEWABLE ENERGY RESOURCES

Renewable Northwest Project
(503) 223-4544

U.S. Export Council for Renewable Energy
National Renewable Energy Laboratory
www.nrel.doe.gov

ADDITIONAL RESOURCES

American Architectural Manufacturers Association

American Institute of Architects
(202) 626-7300
www.aia.org

American Institute of Building Design
(203) 227-3640

American Public Power Association
2301 M Street, N.W.
Washington, D.C. 20037-1484
(202) 467-2900
www.APPAnet.org

Association of Energy Engineers
www.aeecenter.org
(770) 447-5083

Bonneville Power Administration
www.bpa.gov

Energy Efficiency and Renewable Energy Clearinghouse
U.S. Department of Energy
P.O. Box 3048
Merrifield, VA 22116
(800) 363-3732
www.doe.eren.gov

Environmental Services Directory – Washington State
Mattox and Associates
P.O. Box 99486
Seattle, WA 98199

National Association of Home Builders
(800) 368-5242
www.nahb.com

National Energy Information Center
U.S. Department of Energy
www.eia.doe.gov
(202) 586-8800

Pacific Northwest National Laboratory
P.O. Box 999
Richland, WA 99352
(509) 375-2789
www.pnl.gov

Washington Public Utility District Association
www.wpuda.org

Washington State University Cooperative Extension Energy Program
Energy Ideas Clearinghouse
www.energy.wsu.edu

Washington Utilities and Transportation Commission
www.wutc.wa.gov

Western Electric Power Institute (formerly Northwest Electric Light
and Power Association)
www.powerin.org

APPENDIX C. SURVEY INSTRUMENTS

Interview Questions: Energy Efficiency Industry

Hi, my name is _____, calling from ECONorthwest. We're conducting a study for the Washington Department of Community, Trade, and Economic Development to help characterize the energy efficiency and renewable energy industry in the state; understand key issues and concerns; and determine how the agency could better assist the industry. I'm interested in talking with _____ [specific contact person, if known] for about 15-20 minutes. (Is this a good time, or can we schedule another time in the next couple days?) Thanks very much.

First, we're interested in learning more information about your company. (Your replies are for internal information purposes only.)

Company Description Information

- About how large is your company? (e.g., number of employees, sales, etc.)
- What specific energy efficiency products and services does your company manufacture or provide?
- How much of your business, by sales or by employment, is devoted to energy efficiency (approximate percentage)?
- Are the primary markets for your business domestic or international (approximate percentage)? (If business is international... What countries do you actively do business in?) Is Washington state a significant market for your products and services?
- What do you view as your target market, and how do you reach target customers?

Finding Additional Firms

- Which associations and other industry groups is your company a member of, and which trade journals are most important to your industry? Which organizations are particularly helpful with business development or policy concerns?
- Which companies do you see as your main competitors (both in Washington and outside of state)? Who are the main upstream suppliers and downstream companies that your firm works with?

Industry Trends

- How many years has your company been active in the energy efficiency business? Why did you get involved in this business?
- Has the energy efficiency portion of your business increased in size, decreased, or stayed the same in the last several years? (If it has changed, has change occurred rapidly or gradually?)
- How has the size of your specific sector within the energy efficiency industry changed in recent years? (i.e., Is your company's experience indicative of overall industry trends?)
- What types of short-term and long-term trends are affecting your business? (e.g., energy codes and other regulations, energy industry restructuring, changes in funding for conservation, public concern about the environment, international markets, etc.)
- What are your expectations for the future of your business and the industry, and what opportunities do you see for your business in the future?

Public Policy Issues

- What public policies (e.g., taxes, codes and standards, government incentives and subsidies, etc.) have the greatest effect on your industry? (Do public policies provide incentives or disincentives for adoption and use of energy efficiency technologies?)
- How do you expect the restructuring of the electricity industry to affect your business?
- How are reductions in public funding for energy efficiency and conservation (at the Bonneville Power Administration and other utilities) affecting your company?
- Do you think that there is a viable energy efficiency industry in Washington, and what needs to happen to strengthen the industry?
- Have you used the state's trade, business assistance, or economic development services? Are there specific activities or services you would like to see the state provide?
- (Depends on amount of international business described above...) Is your company interested in increasing its exports? If so, are there current barriers to international trade that you face, or areas where you could use assistance? Are policy changes needed?

General

- Are there any other important issues or concerns that you want to raise?

Thank you very much for your time....

Interview Questions: Renewable Energy Industry

Hi, my name is _____, calling from ECONorthwest. We're conducting a study for the Washington Department of Community, Trade, and Economic Development to help characterize the energy efficiency and renewable energy industry in the state; understand key issues and concerns; and determine how the agency could better assist the industry. I'm interested in talking with _____ [specific contact person, if known] for about 15-20 minutes. (Is this a good time, or can we schedule another time in the next couple days?) Thanks very much.

First, we're interested in learning more information about your company. (Your replies are for internal information purposes only.)

Company Description Information

- About how large is your company? (e.g., number of employees, sales, etc.)
- What specific renewable energy products and services does your company manufacture or provide?
- How much of your business, by sales or by employment, is devoted to renewable energy activities (approximate percentage)?
- Are the primary markets for your business domestic or international (approximate percentage)? (If business is international... What countries do you actively do business in?) Is Washington state a significant market for your products and services?
- What do you view as your target market, and how do you reach target customers?

Finding Additional Firms

- Which associations and other industry groups is your company a member of, and which trade journals are most important to your industry? Which organizations are particularly helpful with business development or policy concerns?

- Which companies do you see as your main competitors (both in Washington and outside of state)? Who are the main upstream suppliers and downstream companies your firm works with?

Industry Trends

- How many years has your company been active in the renewable energy business? Why did you get involved in this business?
- Has the renewable energy portion of your business increased in size, decreased, or stayed the same in the last several years? (If it has changed, has change occurred rapidly or gradually?)
- How has the size of your specific sector within the renewable energy industry has changed in recent years? (i.e., Is your company's experience is indicative of overall industry trends?)
- What types of short-term and long-term trends are affecting your business? (e.g., energy codes and other regulations, energy industry restructuring, changes in funding for conservation, public concern about the environment, international markets, etc.)
- What are your expectations for the future of your business and the industry, and what opportunities do you see for your business in the future?

Public Policy Issues

- What public policies (e.g., taxes, codes and standards, government incentives and subsidies, etc.) have the greatest effect on your industry? (Do public policies provide incentives or disincentives for adoption and use of renewable energy technologies?)
- Do you expect the restructuring of the electricity industry to affect your business?
- How are reductions in public funding for renewable energy (at the Bonneville Power Administration and other utilities) affecting your company?
- Do you think that there is a viable renewable energy industry in Washington, and what needs to happen to strengthen the industry?
- Have you used the state's trade, business assistance, or economic development services? Are there specific activities or services you would like to see the state provide?

- (Depends on amount of international business described above...) Is your company interested in increasing its exports? If so, are there current barriers to international trade that you face, or areas where you could use assistance? Are policy changes needed?

General

- Are there any other important issues or concerns that you would like to raise?

Thank you very much for your time....